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ABSTRACT

The present study was designed to determine whether conservation of number, weight, volume, area, and mass could be learned and retained by disadvantaged preschool children when taught by an inexperienced classroom teacher. An instructional sequence of 10-minute lessons was presented on alternate days over a 3 1/2 week period by preservice elementary education majors to 93 children 3-5 years of age. Instructions to the teacher consisted of ten typed lesson plans which permitted flexibility in wording and phrasing but were structured in terms of specific tasks and experiences. Children in the experimental group were subdivided into smaller, homogeneous groups of 4-6 children for training. A control group was exposed to an enriched environment but received no training. Results showed significant gains for the experimental group in 15 of the 18 criterion subtests and significant interaction between chronological age (CA), mental age (MA), and intelligence quotient (IQ) levels. An analysis for retention showed no extinction. Instruction appeared to be effective for students above the 3-year-old level in MA and CA, and for IQ levels above 65. When disadvantaged children were compared with advantaged children of the same MA level, or of the same IQ level, significant differences appeared. (WY)

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THE EFFICACY OF A MATHEMATICS READINESS PROGRAM FOR INDUCING CONSERVATION OF NUMBER, WEIGHT, AREA, MASS, AND VOLUME IN DISADVANTAGED PRESCHOOL CHILDREN IN THE SOUTHERN UNITED STATES

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THE EFFICACY OF A MATHEMATICS READINESS PROGRAM FOR INDUCING CONSERVATION OF NUMBER, WEIGHT, AREA, MASS, AND VOLUME IN DISADVANTAGED PRESCHOOL CHILDREN IN THE SOUTHERN UNTIED STATES

Early efforts to induce conservation, exemplified by the investigations of Smedlund 5 through 13/, Wohlwill 16/, and Mermelstein and Meyer 3/, employed a single variable. In general, this single variate approach met with little measurable success, regardless of the media employed. In contrast, those studies in which a multivariate approach was used, have produced more favorable results. Wallach and Sprott 15/, and Bruner 1/, using number, volume, and mass, respectively, reported significant results in inducing conservation in these media by the use of multiple variables. Moreover, the study by Sonstroen 14/ made very clear the marked interaction between variables in the multivariate approach. All of these studies, in the main, employed subjects of Kindergarten age or older.

In a more recent study, Young 17/ demonstrated that significant results could be obtained in inducing and retaining conservation of number, weight, volume, area, and mass with three and four year old children through the use of a multivariate approach. The subjects were all from advantaged home environments in the Midwestern United States. The results of the study indicated that there was no significant difference in conservation gain between IQ levels. This suggested that, perhaps this same approach might be successfully employed in the instruction of children possessing less than average IQ.

Purpose of the Study.

The present study was designed to determine whether conservation of number, weight, volume, area, and mass could be learned and retained by disadvantaged preschool children when taught by an inexperienced classroom teacher. The two major objectives of the study were incorporated in the following research hypotheses:

(1) The course of lessons which was effective for inducing conservation of number, weight, volume, area, and mass with advantaged preschool children would also be effective with severely disadvantaged children of comparable ages.

(2) The course of lessons which was effective when taught by an experienced teacher is simple and direct

enough to be understood and taught effectively by an inexperienced teacher.

As an aid in the correct age placement of conservation lessons within the quantitative readiness curriculum, a third hypothesis was formulated and tested:

(3) There is no difference in rate of gain between various levels of mental age, chronological age, or intelligence.

On a more theoretical level, two additional problems were investigated.

(4) The concepts so induced would be retained. Those subjects post-tested after a period of time would exhibit no measurable extinction.

(5) If advantaged children were equated with disadvantaged children for levels of MA and IQ, there would be no significant difference in their rate or pattern of learning.

It was reasoned that, the findings would have important practical significance in the development of appropriate curriculum in quantitative concepts for preschool and kindergarten in disadvantaged areas.

Methods and Techniques.

Instruction was initiated with a total of two hundred subjects. A rather large attrition rate, primarily due to factors directly associated with the children's home environment, resulted in complete data being available for ninety-three. The average daily attendance of these subjects was fifty percent.

The study comprised four separate phases:

(1) Pretesting (one week)

(2) Instruction (ten 10 minute lessons administered on alternate days over a three and one-half week period)

(3) Posttesting (one week)

(4) Analysis of the data

Each of the four participating schools was randomly divided into an experimental and a control group. The experimental groups were further subdivided into smaller homogeneous groups of from

four to six students each for instructional purposes. Prescores on a criterion test, constructed by the investigator, provided the basis for the grouping. The subjects ranged in age from three to five years and had a mean IQ of 86.

All lessons were identical for the various experimenal groups with the exception that changes in wording or phrasing were allowed where language seemed to pose a barrier to understanding. Elementary education majors, enrolled at Stephen F. Austin State University, taught each of the groups. None of these students had any previous experience, nor had they begun their practice-teaching courses prior to participating in this study.

Since success in inducing conservation apparently hinges on the multivariate approach, the following variables were utilized in forming the series of ten lessons employed in this study:

(A) Reversibility
(B) Perceptual screening and mental imagery
(C) Physical manipulation by subject and by teacher
(D) Addition-subtraction, subtraction-addition
(E) Compensatory operation
(F) Verbal rule
(G) Reinforcement
(H) Cognitive conflict or equilibrium
(I) Identity
(J) Labelling
(K) Verbal instruction

Each subject, experimental and control, was tested with an individual Stanford-Binet Intelligence Test and with the criterion test, using a counter-balanced design. The criterion test was composed of two equivalent forms of a 57 item conservation test, a test of rote counting, and a test of rational counting. The conservation test was subdivided into eighteen subtests of three to six items each dealing with a different aspect of conservation. Total administration time for this criterion battery was twenty-five minutes.

All test items in the conservation test were taken directly from the tasks used by Piaget to identify and describe his hypothesized stages of development in conservation. In many cases, the tasks were identical with those of Piaget. In his original studies, Piaget emphasized that the materials used in his experiments were those familiar to his subjects.4/ In the present study, where those materials were believed to be unfamiliar to children in the United States, substitutions of materials more familiar to American children were made. For example, egg cups with two or three eggs each (as used by Piaget) were

changed to toy transport trucks with two cars each (criterion test, form one) and to doll plates with three pieces of miniature silverware (form two). In all instances, the questions were the same as those employed by Piaget.

After the teaching period, each subject was posttested on the equivalent form of the criterion test. All of the criterion testing was done by examiners who did not participate in the teaching part of the study. In this manner, a possible source of bias, on the part of the examiners, was eliminated.

Analysis.

A Type I Analysis of Variance Design as described by Lindquist 2/ was used to determine which groups made significant gains. A by-levels design between CA levels, MA levels, and IQ levels was also employed. t-tests were used as tests of significance.

Results.

The findings of the study were as follows:

1. The experimental lessons in conservation of number, weight, volume, area, and mass were effective for improving these concepts among disadvantaged children.

2. The lessons were simple enough to be taught effectively by inexperienced teachers using only printed lesson plans with no additional assistance.

3. There was a significant difference in effectiveness of the lessons at different CA, MA, and IQ levels.

When the data from this study were compared with that of the 1969 study 17/ the following results were observed:

4. For the advantaged child: The lessons were effective at all CA, and IQ levels included in the study. (CA 3-6 years, IQ levels 60-167) They were also effective for all MA levels above three years. (MA 3-9) They were not effective when the MA level was below three years. There was also a marked improvement in gain at IQ levels above 65.

For the disadvantaged child: The experimental lessons were significantly effective for IQ levels of 66-100, but, were not as effective as they had been for the advantaged children in IQ levels below 65 and above 100. The lessons were significantly superior with the disadvantaged child with an MA of 4 years, or

older, but were inferior to the enriched curriculum below this MA. The experimental lessons were also significantly effective for disadvantaged children with a CA of 5 years or older, but were inferior to an enriched environment below CA 5.

5. Because the control group (enriched environment) made satisfactory gains in conservation below 3 years, in contrast to the experimental group, one must necessarily reject the hypothesis that there is a biological limit (physical and/or neurological) at approximately the MA of 3 years, below which conservation could not be taught. One can only assume that the experimental method was not appropriate for use below the 3 year level of MA.

6. The analysis for retention showed that the subjects post-tested six weeks following instruction showed significantly (.05) greater gain in conservation than those post-tested immediately following instruction. No extinction had occurred; on the contrary, the subjects had retained and added to their concept of conservation.

7. There was a significant difference in the level at which the lessons should be placed in the two social classes.

The following results were observed about which no prior hypotheses had been formulated:

8. When the advantaged child and the disadvantaged child were matched in MA, the advantaged child still made significantly greater gains in this type of learning, which was basically logic. The advantaged child's initial pretest score was higher and his gain was greater than the disadvantaged child with the same MA.

9. When the advantaged child and the disadvantaged child were matched for IQ level, the advantaged child made significantly greater gains in learning.

10. When the advantaged child and the disadvantaged child were matched in CA, at the 5-year level, the advantaged child averaged 2¼ years older in MA. (It may be noted that the data indicated that the lessons should be placed at the 3-year old level with the advantaged child and the 5-year old level with the disadvantaged child.)

11. Since all levels showed gain in conservation concepts and because the rate of gain was significantly affected by difference in teaching methods, one may conclude that conservation is a learning process and not primarily a biological maturational process for the MA levels 2½ through 9, the limits included in this study.

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It appears that conservation does not suddenly occur at ages 7, 9, or 12, but, is acquired gradually, bit by bit, from infancy (2 years or younger) through the years and reaches maturity (or the stage of conservation) as soon as sufficient evidence has been brought to the attention of the subject. This might be at age 3 or 4 as pointed out by Young 18/ provided the evidence is systematically brought to the attention of the child, or, at ages 7, 9, or 12, if this were left to chance.

12. Because of the pattern of interaction between the experimental method and control method it seemed that as soon as a language readiness was achieved at about CA 3, for advantaged children, and a CA of 5 for this particular group of disadvantaged children, the structured play (experimental method) was superior whenever the learning task was difficult in relation to the maturity of the child. However, when the task was easy by virtue of the child nearing the completion of the concept by incidental observation, the method was not a crucial matter and made no significant difference.

13. The experimental method was significantly superior for teaching rational counting to the disadvantaged children at the MA level of 3-5. Since it was not primarily the purpose of the lessons to teach rational counting, it was assumed that the heavy emphasis on the use of concrete objects, coupled with occasional counting, accounts for the effectiveness with this young age group.

Recommendations.

The results of the study indicate that these lessons in conservation could profitably be placed in the nursery school and kindergarten curriculum of children with an MA of 4 years or older, or in a curriculum for 3 year olds who are well advanced in language development.

With underprivileged children, the correct placement would be in kindergarten or early in first grade.

Because the learning showed a gradual increase at every level, it would seem wisest to repeat the conservation lessons using new materials. It is the opinion of the researcher that this should be done approximately once a year. However, no evidence exists in the present study as to the optimum length of the cycle. This is only a subjective judgment on the part of the researcher after working with approximately 300 preschool children, using the described lessons.

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